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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/078,016	02/15/2002	Scott Brad Herner	A5031/T43300	5510

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APPLIED MATERIALS, INC.
2881 SCOTT BLVD. M/S 2061
SANTA CLARA, CA 95050

EXAMINER

NGUYEN, THANH T

ART UNIT PAPER NUMBER

2813

DATE MAILED: 09/29/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/078,016

Applicant(s)

HERNER, SCOTT BRAD

Examiner

Thanh T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 July 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-22 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-22 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____. 6) ☐ Other: _____

DETAILED ACTION

Response to Arguments

Applicant's arguments with respect to claims 1-22 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cho (U.S. Patent No. 6,287,964).

Teaches a method for the formation of a refractory metal nucleation layer on semiconductor device substrate, the method comprising:

Depositing a metallic barrier layer (Ti/TiN, 14, see col. 4, lines 10-14) on the semiconductor device substrate (11),

Exposing the metallic barrier layer (14) to silicon containing gas (SiH₄, see figure 2C, col. 4, lines 26-41) to form a layer of silicon (15) on the metallic barrier layer (14);

Purging the silicon containing gas (see col. 4, lines 46-50);

Exposing the layer of silicon (15) to a refractory metal containing gas (WF₆, see figure 2D, col. 4, lines 42-50) such that the refractory metal containing gas undergoes a reduction

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reaction with the layer of silicon resulting in the formation of a refractory metal layer (W, 16) on the metallic barrier layer (14).

It is obvious that silicon-containing gas have to purge out before other gas (Tungsten flow in) because the process would prevent the formation of tungsten silicide.

Claims 1-20, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cho (U.S. Patent No. 6,287,964) in view of Takagi et al. (U.S. Patent No. 6,107,200), and further in view of Chung et al. (U.S. Patent No. 6,498,399).

Teaches a method for the formation of a refractory metal nucleation layer on semiconductor device substrate, the method comprising:

Depositing a metallic barrier layer (Ti/TiN, 14, see col. 4, lines 10-14) on the semiconductor device substrate (11),

Exposing the metallic barrier layer (14) to silicon containing gas (SiH_4 , see figure 2C, col. 4, lines 26-41) to form a layer of silicon (15) on the metallic barrier layer (14),

Purging the silane gas (see col. 4, lines 45-50);

Exposing the layer of silicon (15) to a refractory metal containing gas (WF_6 , see figure 2D, col. 4, lines 42-50) such that the refractory metal containing gas undergoes a reduction reaction with the layer of silicon resulting in the formation of a refractory metal layer (W, 16) on the metallic barrier layer (14),

Purging the tungsten hexafluoride; and

Depositing a tungsten core layer on the tungsten layer using tungsten CVD reaction wherein WF_6 is reduced with H_2 (see figure 2F, col. 5, lines 1-8).

It is obvious that silicon-containing gas have to purge out before other gas (Tungsten flow in) and vice versa because the process would prevent the formation of tungsten silicide.

It would be obvious to one ordinary skill in the art to form a plurality of tungsten layers and silicon layers alternatively with the same process as using in the first tungsten layer and the first silicon layer since it is well known in the art to repeat the same process for multiple effects. See *St. Regis paper, Co. V. Bemis Co. Inc.* 193 USPQ 8, 11 (7th circuit 1977).

However, Cho et al. does not teach a method of forming a barrier layer by using tantalum nitride, the pressure range, and the thickness range of forming a layer.

Takagi et al. teaches forming a TiN layer with the thickness of about 400Å (see col. 9, lines 37-47, figure 3C), forming tungsten layer with thickness of 300 and the pressure of about 3 Torr (see col. 9, lines 48-60, figure 3d).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form a TiN layer with the thickness of about 400Å, and forming tungsten layer with thickness of 300 and the pressure of about 3 Torr in process of Cho et al. as taught by Takagi et al. because the process would provide a small resistance of the tungsten wiring layer, the contact resistance can be lowered and stable wiring width, an also improve the processing speed of the semiconductor device.

The thickness range and the pressure range are considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in *In re Aller* 105 USPQ233, 255 (CCPA 1955), the selection of reaction parameters such as temperature and concentration would have been obvious:

“Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however,

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changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art...such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

In re Aller 105 USPQ233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948); *In re Scherl* 70 USPQ 204 (CCPA 1946); *In re Irmischer* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

Therefore, one of ordinary skill in the requisite art at the time the invention was made would have used any thickness range and pressure range suitable to the method in process of Cho et al. in order to optimize the process.

Chung et al. teaches forming a barrier layer TaN or TiN in the opening (see figure 1, col. 10, lines 60-65), and forming a tungsten metal layer on the TaN layer (see col. 10, lines 52-55) to fill the opening.

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form a TaN barrier in the opening in process of Cho et al. as taught by Chung et al. because the process would prevent diffusion of the conductive metal into the dielectric layer.

Response to Arguments

Applicant's arguments with respect to claims 1-22 have been considered but are moot in view of the new ground(s) of rejection.

Applicant contends that none of the prior art taught or suggested a method of purging the silane gas and purging the tungsten hexafluoride. However, in response to applicant that Cho et

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al. teaches a method of purging the silane gas (see col. 4, lines 45-50) and purging the tungsten hexafluoride (see col. 4, lines 51-55). It is also obvious that silicon-containing gas have to purge out before other gas (Tungsten flow in) and vice versa because the process would prevent the formation of tungsten silicide.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (703) 308-9439, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:30AM to 4:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached on (703) 308-4940. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (**See MPEP 203.08**).



Thanh Nguyen
Patent Examiner
Patent Examining Group 2800

TTN